Oscillations And Waves JEE Main PYQ - 1

Total Time: 25 Minute **Total Marks:** 40

Instructions

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1. Test will auto submit when the Time is up.
2. The Test comprises of multiple choice questions (MCQ) with one or more correct answers.
3. The clock in the top right corner will display the remaining time available for you to complete the examination.

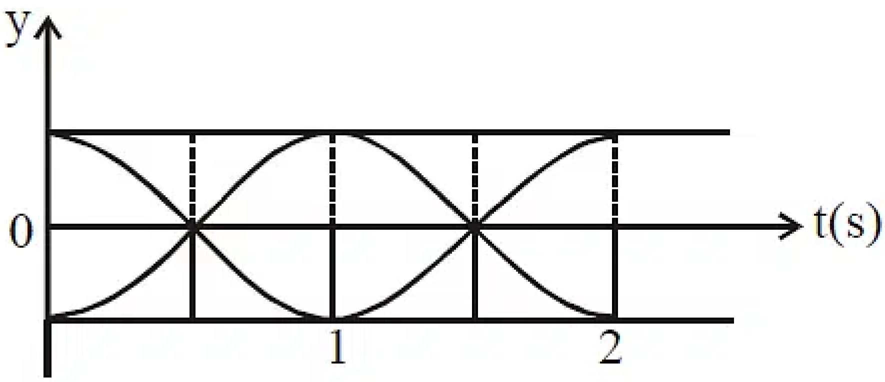
Navigating & Answering a Question

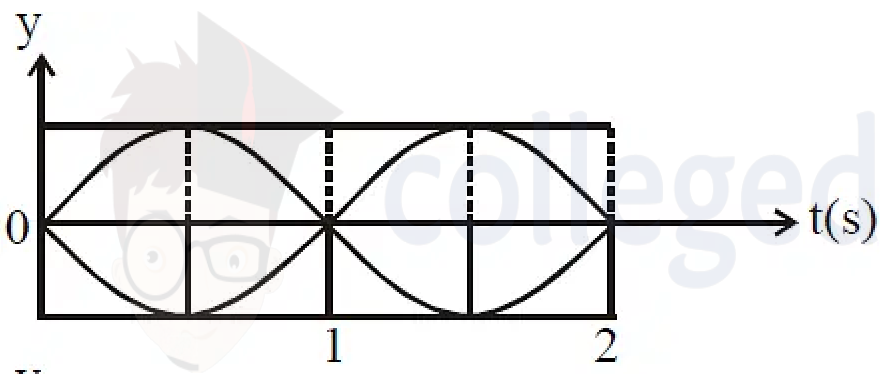
1. The answer will be saved automatically upon clicking on an option amongst the given choices of answer.
2. To deselect your chosen answer, click on the clear response button.
3. The marking scheme will be displayed for each question on the top right corner of the test window.

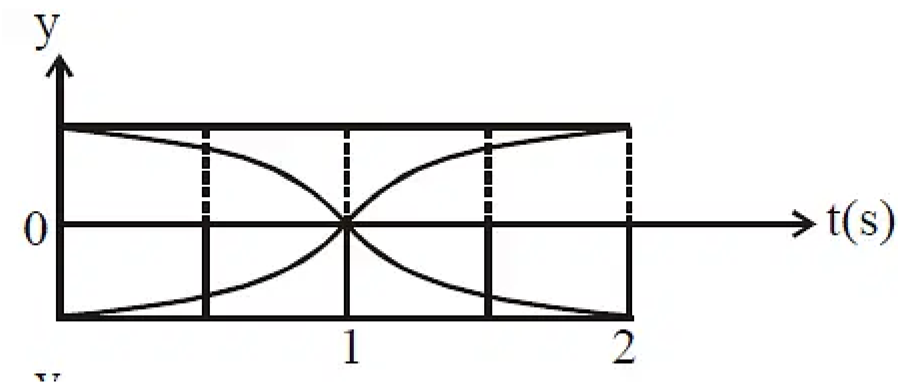
Oscillations And Waves

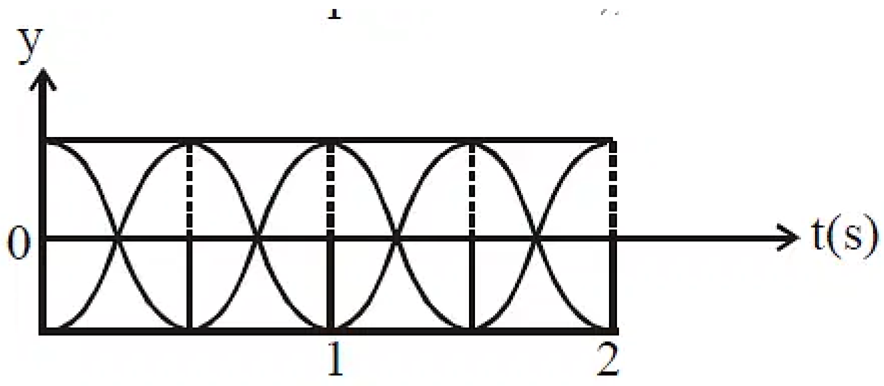
1. The correct figure that shows, schematically, the wave pattern produced by superposition of two waves of frequencies $9\,Hz$ and $11\,Hz$ is : **(+4, -1)**

[10 April 2019 II]

a. 

b. 

c. 

d. 

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2. A resonance tube is old and has jagged end. It is still used in the laboratory to determine velocity of sound in air. A tuning fork of frequency $512\,Hz$ produces first resonance when the tube is filled with water to a mark $11\,cm$ below a reference mark, near the open end of the tube. The experiment is repeated with another fork of frequency $256\,Hz$ which produces first resonance when water reaches a mark $27\,cm$ below the reference mark. The velocity of sound in air, obtained in the experiment, is close to: **(+4, -1)**

[12 Jan. 2019 II]

a. $328\,ms^{-1}$

b. $322\,ms^{-1}$

c. $341\,ms^{-1}$

d. $335\,ms^{-1}$

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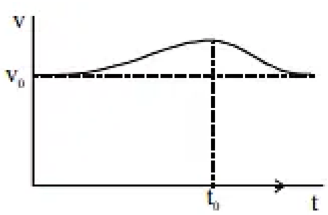
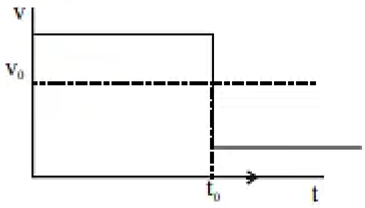
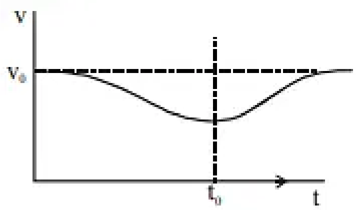
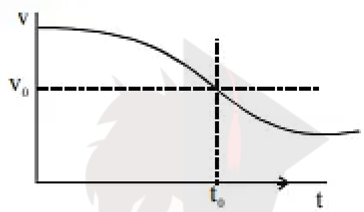
3. A sound source S is moving along a straight track with speed v, and is emitting sound of frequency v_0 (see figure). An observer is standing at a finite distance, at the point O, from the track. The time variation of frequency heard by the observer is best represented by : **(+4, -1)**
(t_0 represents the instant when the distance between the source and observer is minimum)

[Sep. 06, 2020 (I)]

a. 

b. 

c. 

d. 

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4. A wire of length L and mass per unit length $6.0 \times 10^{-3}\, kgm^{-1}$ is put under tension of $540\, N$. Two consecutive frequencies that it resonates at are: $420\, Hz$ and $490\, Hz$. Then L in meters is : **[9 Jan. 2020 (II)]** **(+4, -1)**

a. $8.1\, m$

b. $2.1\, m$

c. $1.1\, m$

d. $5.1\, m$

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5. Two factories are sounding their sirens at $800\, Hz$. A man goes from one factory to other at a speed of $2\, m/s$. The velocity of sound is $320\, m/s$. The number of beats heard by the person in one second will be : **(+4, -1)**

[Online April 11, 2014]

a. 2

b. 4

c. 8

d. 10

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6. A uniform string of length $20\,m$ is suspended from a rigid support. A short wave pulse is introduced at its lowest end. It starts moving up the string. The time taken to reach the support is : (take $g = 10\,ms^{-2}$) **(+4, -1)**

[2016]

a. $2\pi\sqrt{2}s$

b. $2s$

c. $2\sqrt{2}s$

d. $\sqrt{2}s$

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7. A string of length $1\,m$ and mass $5\,g$ is fixed at both ends. The tension in the string is $8.0\,N$. The siring is set into vibration using an external vibrator of frequency $100\,Hz$. The separation between successive nodes on the string is close to : **(+4, -1)**

[10 Jan. 2019 (I)]

a. 16.6 cm

b. 20.0 cm

c. 10.0 cm

d. 33.3 cm

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8. A toy-car, blowing its horn, is moving with a steady speed of $5\,m/s$, away from a wall. An observer, towards whom the toy car is moving, is able to hear 5 beats per second. If the velocity of sound in air is $340\,m/s$, the frequency of the horn of the toy car is close to : **(+4, -1)**

[Online April 10, 2016]

a. 680 Hz

b. 510 Hz

c. 340 Hz

d. 170 Hz

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9. A wave on a string is described by (,) = 0.005 sin (6.28 - 314) in which all quantities are in SI units. It's wavelength is _______. **(+4, -1)**

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10. The displacement equations of two interfering waves are given by **(+4, -1)**

$y_1 = 10\sin\left(\omega t + \frac{\pi}{3}\right)$ cm ,

$y_2 = 5[\sin\omega t + \sqrt{3}\cos\omega t]$ cm respectively. **[31-Jan-2023 Shift2]**

The amplitude of the resultant wave is ___ cm

Answers

1. **Answer: d**

Explanation:

$f_{beat} = 11 - 9 = 2\ Hz$
$\therefore$ Time period of oscillation of amplitude
$= \frac{1}{f_{beat}} = \frac{1}{2} Hz$
Although the graph of oscillation is not given, the equation of envelope is given by option

Concepts:

1. **Waves:**

Waves are a disturbance through which the energy travels from one point to another. Most acquainted are surface waves that tour on the water, but sound, mild, and the movement of subatomic particles all exhibit wavelike properties. inside the most effective waves, the disturbance oscillates periodically (see periodic movement) with a set frequency and wavelength.

Types of Waves:

Transverse Waves -

Waves in which the medium moves at right angles to the direction of the wave.

Examples of transverse waves:

- Water waves (ripples of gravity waves, not sound through water)
- Light waves
- S-wave earthquake waves
- Stringed instruments
- Torsion wave

The high point of a transverse wave is a crest. The low part is a trough.

Longitudinal Wave -

A longitudinal wave has the movement of the particles in the medium in the same dimension as the direction of movement of the wave.

Examples of longitudinal waves:

- Sound waves
- P-type earthquake waves
- Compression wave

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2. Answer: a

Explanation:

$\frac{\lambda_1}{4} = 11\,cm$ so ,
$\frac{v}{512 \times 4} = 11\,cm$
$\frac{\lambda_2}{4} = 27\,cm$ so ,
$\frac{v}{256 \times 4} = 27\,cm$
$(2) - (1)\ \frac{v}{256 \times 4} \times 0.5 = 0.16$
$v = 0.16 \times 2 \times 4 \times 256$
$v = 328\,m/s$
$\frac{v}{256 \times 4} \times 0.5 = 0.16$
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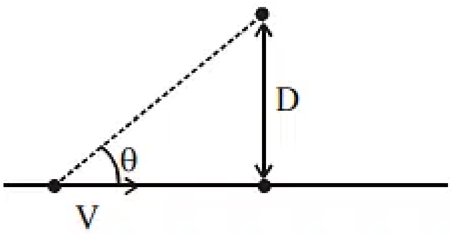
3. **Answer: d**

Explanation:



While approaching

$$\nu = \nu_0\left(\frac{c}{c - v\cos\theta}\right)$$

While receding

$$\nu = \nu_0\left(\frac{c}{c + v\cos\theta}\right)$$

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4. **Answer: b**

Explanation:

$$\frac{nv}{2\ell} = 420$$
$$\frac{(n+1)v}{2\ell} = 490$$
$$\frac{v}{2\ell} = 70$$
$$\ell = \frac{v}{140} = \frac{1}{140}\sqrt{\frac{540}{6\times10^{-3}}} = \frac{1}{140}\sqrt{90\times10^{3}}$$
$$\ell = \frac{300}{140} = 2.142$$

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5. **Answer: d**

Explanation:

Number of beats, b is

$b = \frac{2V_o n}{V_s}$

$= \frac{2\times2\times800}{320} = 10$

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6. Answer: c

Explanation:

$$\frac{dy}{dt} = \sqrt{\frac{gy\rho A}{\mu}}$$
$$\frac{dy}{dt} = \int \sqrt{gy}$$
$$\int \frac{dy}{\sqrt{y}} = \sqrt{g}dt$$
$$\frac{y^{-\frac{1}{2}+1}}{-\frac{1}{2}+1}\Big|_0^l = \sqrt{g}t\Big|_0^t$$
$$t = 2\sqrt{\frac{20}{10}} = 2\sqrt{2}\,\mathrm{sec}$$

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7. **Answer: b**

Explanation:

Velocity of wave on string
$V = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{8}{5} \times 1000} = 40m/s$
Now, wavelength of wave $\lambda = \frac{v}{n} = \frac{40}{100}m$
Separation b/w successive nodes, $\frac{\lambda}{2} = \frac{20}{100}m$
$= 20\,cm$

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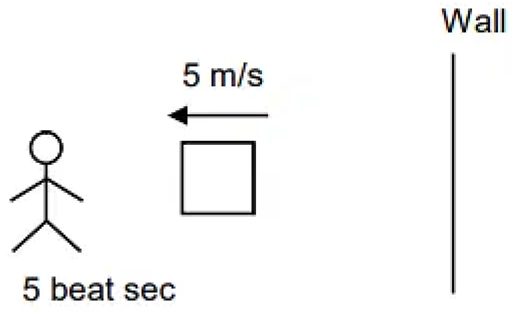
8. Answer: d

Explanation:



$$F_{\text{dir}} = \left(\frac{340}{340-5}\right) f$$
$$f_{\text{ind}} = \left(\frac{340}{340+5}\right) f$$
$$f_{\text{ind}} - f_{\text{dir}} = 5$$
$$\left\{\left(\frac{340}{340+5}\right)\left(\frac{340}{340+5}\right)\right\} f = 5$$
$$340\left\{\frac{10}{(300-5)(340+5)}\right\} = 5$$
$$f = \frac{340\times 5}{10}$$
$$f = 170\,Hz$$

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9. **Answer: 1 - 1**

Explanation:

Explanation:
Given:
The wave on a string is described by
$(\; , \;) = 0.005\sin(6.28 \quad - 314 \quad)$...(i)
Displacement of a general plane progressive wave is given as
$(\; , \;) = \quad \sin(\quad - \quad)$....(ii)
where,
$= \frac{2}{\;}$, wave number and $= \frac{2}{\;}$, angular frequency
Substituting the values in eq. (ii), we get
$(\; , \;) = \quad \sin(\frac{2}{\;} \quad - \frac{2}{\;} \quad)$...(iii)
Comparing eqs. (i), (ii) and (iii), we get
$= 0.005$
$= 6.28 = \frac{2}{\;}$
$= \frac{2}{6.28}$
$= \frac{2 \times 3.14}{6.28} = \frac{6.28}{6.28} = 1\,m$
Hence, the correct answer is 1.

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10. **Answer: 20 - 20**

Explanation:

The correct answer is 20.

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